Winter 2013

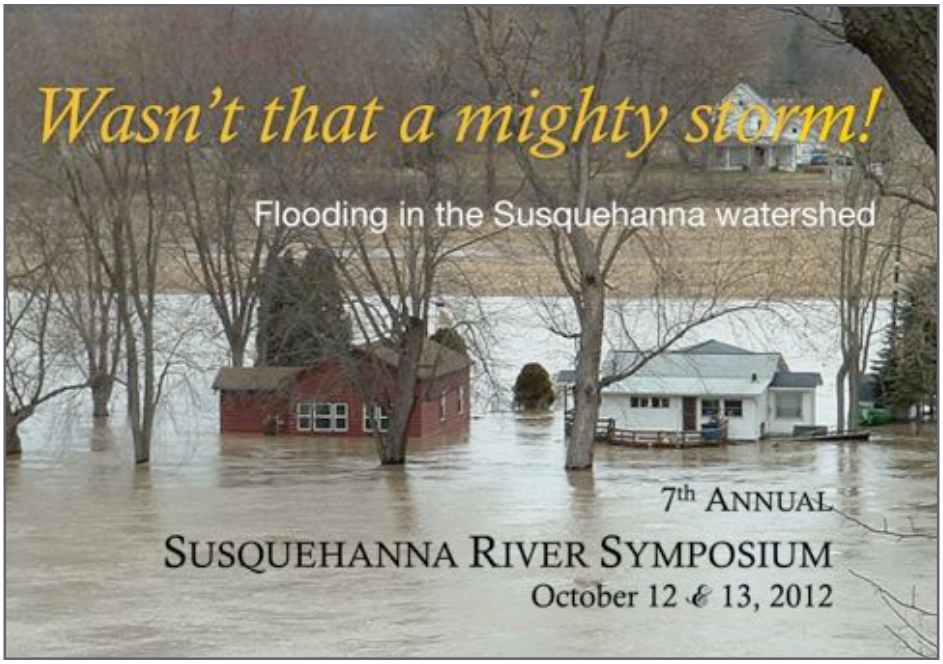
Bucknell River Reporter

Bucknell University Environmental Center

Bucknell River Reporter

A QUARTERLY NEWSLETTER BY THE SUSQUEHANNA RIVER INITIATIVE

VOL. 1, ISSUE. 1 BUCKNELL UNIVERSITY ENVIRONMENTAL CENTER WINTER 2013



This year's symposium highlighted the record-breaking floods of September 2011, precipitated by Tropical Storm Lee. Almost 18 inches of rain fell over a narrow portion of the basin and caused extensive flooding in Lewisburg and other flood-prone areas.

The symposium brought together scientists, students, engineers, planners and community leaders to discuss flooding in the watershed and its impacts on aquatic life, infrastructure, stream channels, and the Chesapeake Bay.

Speakers came from Bucknell (President Bravman), the Susquehanna River Basin Commission (Jas. Richenderfer); the Chesapeake Bay Foundation (M.J. Ehrhart); the Mid Atlantic Flood Forecasting Center (Wm. Marosi); the US Geologic Survey (Mark Roland); The Pennsylvania Fish and Boat Commission (Geoff Smith), and the Pennsylvania Department of Transportation (T.J. Cunningham).

More than 80 poster presentations were displayed by student interns and faculty from colleges in the Central Susquehanna region. There were many lively discussions of the poster material in the Terrace Room of the Langone Center (photos on page 2).

Additional photos and symposium materials, including research poster titles and abstracts, can be downloaded from:
`www.bucknell.edu/riversymposium`

Welcome!

"Something is always happening on the river" is an old song — and a present reality — thanks to Bucknell's "Susquehanna River Initiative." This newsletter is about what's happening on the river, as a result of "the Initiative," and of natural and human influences.

We will present news about "The River," and about what Bucknell faculty, staff and students are doing to help us understand the dynamics of this vital river. The Susquehanna provides up to sixty percent of the fresh water inflow to the Chesapeake Bay, draining a large portion of Pennsylvania and all of the Bucknell campus! The Initiative deals mostly with the central portion of this vast watershed, from Lock Haven to Scranton to Harrisburg.

The articles are short, on purpose, except for the *Diving Deeper* article — which in this issue features a study by Professor R. Craig Kochel and several geology students.

Additional information on Initiative efforts is available online:
`www.bucknell.edu/sri`

We plan to include lots of links to web pages, in case something catches your interest!

Dr. Fred Swader
Editor

SUSQUEHANNA
RIVER INITIATIVE

Bucknell
UNIVERSITY
ENVIRONMENTAL CENTER

2012 River Symposium

Wasn't That A Mighty Storm! - Flooding in the Susquehanna Watershed, Oct. 12-13, 2012

Bucknell River Reporter

Vol. 1, Issue 1 (Spring 2013)

Published quarterly by the *Susquehanna River Initiative*, which is devoted to creating new teaching, research, outreach activities that connect students and faculty to the Susquehanna and helping to monitor and improve the health and sustainability of our watershed.

Editorial Team:

Fred Swader, Ph.D., *Newsletter Editor*
Benjamin Hayes, Ph.D., *Initiative Director*
Sean Reese, M.S., *Aquatic Scientist*
Carol High, *Office Coordinator*
Tel: 570-577-1830

Email: susquehanna.river.initiative@bucknell.edu
Web: www.bucknell.edu/sri

Mailing Address:

Bucknell University Environmental Center
One Dent Drive
Lewisburg, PA 17837

Previous symposia:

From the Branches to the Confluence: The Susquehanna River Heartland for Environmental Studies (2006)
Remediation of Abandoned Mine Discharge (AMD) in the Watershed (2007)
The Susquehanna River and Agriculture (2008)
Cultures at the Confluence: Native Americans and the River (2009)
The Susquehanna River: Our Vital Resource — Science and the River (2010)
River Towns in the 21st Century (2011)
Wasn't that a Mighty Storm! — Flooding in the Susquehanna Watershed (2012)

Upcoming symposium:

A Fragmented River: Dams on the Susquehanna
October 18 & 19, 2013

Monitoring water quality in the river

By Matthew McTammany, Sean P. Reese and Benjamin R. Hayes

A major effort underway by the Initiative is to continuously monitor water quality at selected locations in the West and North branches of the river. Little is known about the water chemistry of the river and how it relates to land use, discharges, and seasonal changes in aquatic plant growth and nutrient loads.

In 2009, we partnered with the Susquehanna River Basin Commission to configure and install two YSI 6600 water quality sondes and telemetry data logger systems at water treatment plants on the West Branch near Milton and on the North Branch near Danville. Since then, the instruments have recorded fluctuations in water quality and are now part of the SRBC's Early Warning System, which is used by a number of state and federal regulatory agencies to alert them to sudden changes in river conditions.

Bucknelll scientists have developed new web-portal software which displays time series of water quality conditions at selected locations in the Susquehanna watershed. This examples shows water temperature (red) and dissolved oxygen levels (green) in the West Branch at at Milton, Pennsylvania

View this graph with real-time data online!

View online

Porfolio of all water quality parameters at the Milton side for a period of one week, January 24-31, 2013 (above). Regular maintenance of the sondes ensure accurate readings (below).

Each sonde is equipped with five interchangeable sensors which measure water depth, temperature, dissolved oxygen, pH, turbidity, oxidation-reduction potential, and chlorophyl. They receive monthly maintenance and calibration to ensure accurate data.

The data are stored on an internal datalogger and uploaded every 15 minutes to a computer server at Bucknell. Custom software was written to store the data in a MySQL database and display the real-time data feeds in an interactive web portal on the Initiative's web site. Anyone can view the time series and selected various water quality parameters. The website also has an interactive map that shows the locations of the sondes. Users can also view statistics and plots of the data, as well as download the raw data in Excel, PDF, and HTML tables.

The Initiative also has uses several "roving" sondes at other locations in the watershed. During the summer of 2009, two sondes were deployed for several months below Sunbury and documented that even below the confluence the waters from the North and West branches do not mix.

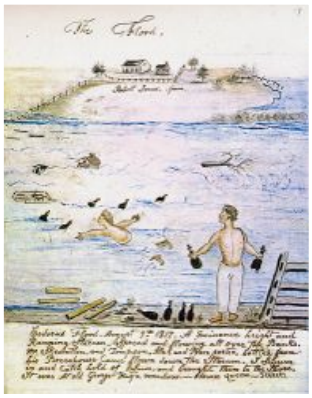
This water quality monitoring network is opening new doors for Bucknell students and for collaboration and research with other universities and state and federal agencies. The Initiative hopes to expand its network to include live river cams and additional water quality sondes placed in the river below the confluence and up the West and North Branches.

Preliminary results of the river water quality network have been presented at the annual meeting of the North American Benthological Society and the American Society of Civil Engineers' Hydraulic Measurement and Experimental Methods Conference.

Visit **www.bucknell.edu/sri** to view the real-time data.

MAJOR FLOODS IN THE SUSQUEHANNA WATERSHED

- **February 1692** - Major flood of the Susquehanna and its tributaries.
- **February 12, 1731** - Major flood of the Susquehanna and its tributaries.
- **February 17, 1733** - Major flood of the Susquehanna and its tributaries.
- **January 28, 1737** - Major flood of the Susquehanna and its tributaries.
- **January 7, 1762** - Major flood of the Susquehanna and its tributaries.



- **March 15, 1784** - Major flood of the Susquehanna and its tributaries.
- **October 5, 1786** - Major flood of the Susquehanna and its tributaries, called the "The Great Pumpkin Flood" due to many pumpkins that floated away.
- **October 1, 1787** - Major flood of the Susquehanna and its tributaries.
- **April 1800** - Major flood of the Susquehanna and its tributaries.
- **April 23, 1804** - Major flood of the Susquehanna and its tributaries.
- **November 20, 1810** - Major flood of the Susquehanna and its tributaries. Also called "The Great Pumpkin Flood".
- **July 20, 1824** - Major flood of the Susquehanna and its tributaries.
- **March 5, 1831** - Major flood of the Susquehanna and its tributaries.
- **May 17, 1834** - Major flood of the Susquehanna and its tributaries.
- **February 12, 1837** - Major flood of the Susquehanna and its tributaries
- **October 9, 1847** - Major flood of the Susquehanna and its tributaries. Flood destroys nearly every building in Karthos and Keating. Settlers suffering from hunger along the West Branch dispatched canoes for flour and other provisions.
- **February 7, 1853** - Major flood of the Susquehanna and its tributaries.
- **September 28, 1861** - Major flood of the Susquehanna and its tributaries. Flood ravages the Sinnemahoning valley after a log drive hangs up about a mile below the creek and torrential rain causes the river and creek to flood rapidly. Many buildings, along with rafts and logs, jam against the railroad bridge and sweep it away. Bodies from cemeteries rise from their graves and are swept by.
- **March 17, 1865** - Major flood of the Susquehanna and its tributaries, called the “St. Patrick's Day Flood,” carries away several houses and an enormous amount of logs and timber rafts.
- **February 1872** - Major flood of the Susquehanna and its tributaries caused by ice breakup.
- **May 30 - June 1, 1889** - Major flood of the Susquehanna and its tributaries caused by a major storm from the west. Severely damages towns of Renovo, Lock Haven, Williamsport, and Sunbury.
- **1894** - Major flood of the Susquehanna and its tributaries.

- **1902 and 1904** - Major floods of the Susquehanna and its tributaries.

- **1910** - Major ice flood of the Susquehanna and its tributaries caused by rain-on-snow in March.

- **1927** - Major flood of the Susquehanna and its tributaries.
- **March 18, 1936** - Major flood of the Susquehanna and its tributaries, also known as the "St. Patrick's Day Flood".

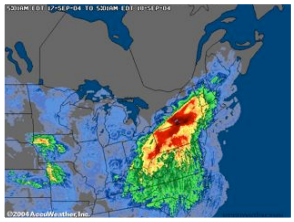
Result of two successive "extraordinarily heavy rainstorms" at a time when large accumulations of snow already covered the ground. Statewide, eighty-four people died in the flood. The flood's significance extended beyond its high waters as it became the impetus for the federal government to pass important legislation for extensive flood-related projects as part of Great Depression Era policy making.

- **1946** - Major flood of the Susquehanna and its tributaries.
- **1955** - **Hurricane Diane** slams the watershed in August, destroying roads.
- **1964** - Major flood of the Susquehanna and its tributaries.

- **June 1972** - Major flood of the Susquehanna and its tributaries caused as **Hurricane Agnes** dumps 28,050 billion US gallons (106.2 km³) of water on the Susquehanna basin. 50 lives lost in Pennsylvania and $2.8 billion dollars of damage in Susquehanna watershed alone.

- **1977** - Heavy rains on thick snow causes severe ice flood in North and West Branches of the watershed.

- **January 19–20, 1996** - Major flood of the Susquehanna and its tributaries following melt of winter snowfall.
- **September 2004** - Major flood of the Susquehanna and its tributaries caused by the remnants of **Hurricane Ivan**.



- **September 2011** - Major flood of the Susquehanna and its tributaries caused by **Tropical Storm Lee**.

Geomorphic Impacts of Tropical Storm Lee in North-Central PA

Diving Deeper

By R. Craig Kochel, Professor of Geology

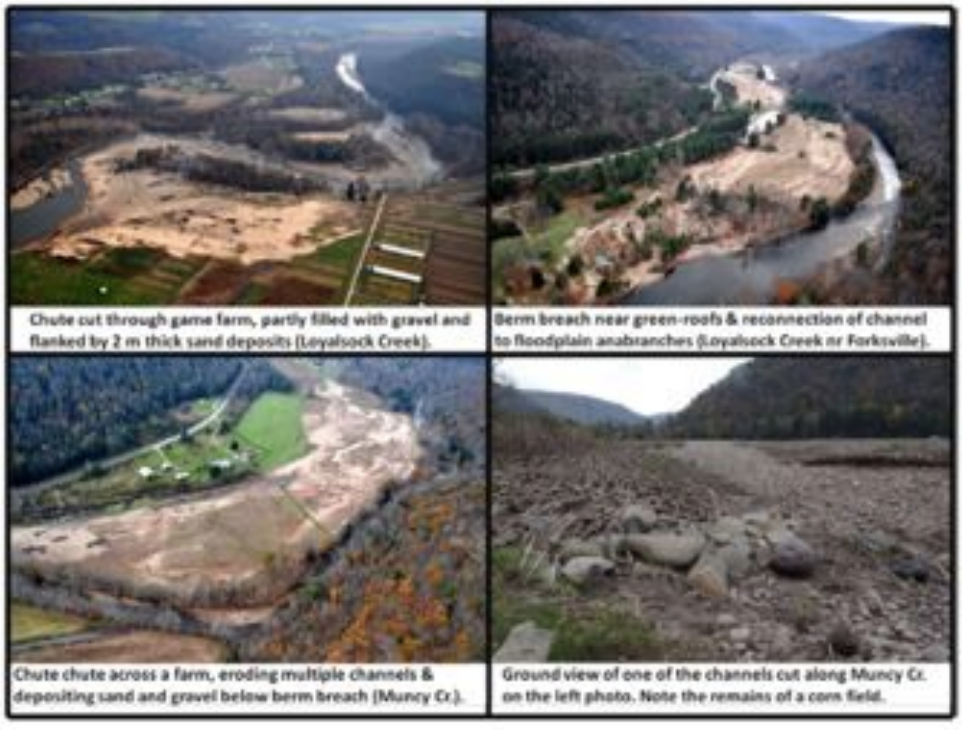
More than a foot of rain over two days in September 2011 resulted in catastrophic flooding on several streams flowing off the Appalachian Plateau in North-Central Pennsylvania. Although preliminary estimates from the U.S. Geological Survey estimate recurrence intervals approached or exceeded 100 years along many streams, the magnitude of geomorphic change and related damage to property and infrastructure experienced by these rivers was truly remarkable. Using over 1000 images from a low-altitude helicopter reconnaissance photography flight by Craig Kochel and Ben Hayes of Bucknell University, four Geology students (Jason Muhlbauer, Darin Rockwell, Zac Hancock, and Matt Sirianni) are completing a detailed GIS and field study of the geomorphic impacts of the flood along Lycoming, Loyalsock, Muncy, and Fishing creeks.

The Research

Thus far, we have completed GIS mapping of post-flood geomorphic changes along these four gravel-bed streams using the June 2011 Bing Photos as the base from which we mapped changes from continuous helicopter photos taken on November 3, 2011. This detailed database includes changes in: 1) channel position; 2) active channel width; 3) gravel bars and islands; 4) exposed bedrock; 5) newly-formed and reactivated chutes and chute bar complexes; and 6) extent of floodplain inundation. Extensive changes to the channel, streambanks, and floodplains occurred during the flood. Common changes included erosion of extensive channels, called chutes, across the insides of meander bends. In many areas, flooding breached anthropogenic berms constructed years ago to channelize the streams into a single channel from their natural multi-threaded character during high flow events. Reconnection of the main channel and floodplain anabranches (channels) occurred at many locations as berms were breached or overtopped. Extensive channel migration and bank erosion resulted in destruction of homes, roads, and bridges throughout the region. The volume of gravel transported by the flood was enormous. GIS mapping shows that most gravel bars extended greatly and many pulses of gravel were transported downstream. Ongoing analysis of the GIS data will provide volume estimates of the gravel and other sediments transported by the flood.

Our research on the impacts of the September 2011 flood ties in closely with nearly two decades of study we have been doing related to the legacy of widespread historical logging in north-central Pennsylvania on stream behavior. Dendrogeomorphic (tree ring age dating) research in Lycoming Creek and other streams indicate that stream channels and floodplains filled extensively with sediment resulting from hillslope erosion during clearcutting between 1850 and 1930. Since 1930, as hillslopes reforested and began to deliver sediment-free clear water to these streams, channels have been widening and remobilizing the logging fill sediments downstream as pulses or waves of gravel.

In places such as the reach along Lycoming Creek from Roaring Branch to Ralston (and along areas of its tributary Grays Run) this newly-released gravel has been filling stream channels as extensive gravel bars and facilitating extensive floodplain erosion. These disequilibrium zones can be seen along Loyalsock, Fishing, and Muncy Creek, as well as other streams. This is a regional phenomenon that Jerry and Sue Miller, Dale Ritter, and I first discovered in the 1980s in Southern Illinois and seems to be common throughout the eastern USA.



Chute cut through game farm, partly filled with gravel and flanked by 2 m thick sand deposits (Loyalsock Creek).

Berm breach near green-roofs & reconnection of channel to floodplain anabranches (Loyalsock Creek nr Forksville).

Chute chute across a farm, eroding multiple channels & depositing sand and gravel below berm breach (Muncy Cr.).

Ground view of one of the channels cut along Muncy Cr. on the left photo. Note the remains of a corn field.

(continued from previous page)

Stream morphology is controlled by the volume and type of sediment and water delivered to the channel from the watershed. Any changes in sediment or discharge result in stream disequilibrium and adjustments in the channel, i.e., changes in channel pattern such as meandering to braided, changes in channel geometry, and changes in channel slope.

Historical changes in land use, such as logging and then reforestation, have produced enormous changes in sediment loading to streams, and they are still responding to these changes many decades later. Just now, large pulses of gravel from erosion of the logging fills along the channels are being transported downstream through these rivers during floods, resulting in disequilibrium reaches where streams rapidly avulse — change position during floods — where streams return to multi-thread (anastomosing) systems consistent with the movement of large volumes of gravel, and where floodplains are rapidly being eroded. We are witnessing a major shift in stream geometry and morphology, facilitated by large floods that began with Hurricane Agnes in 1972, followed by floods in January 1996, Hurricane Ivan in September 2004, and most recently the September 2011 flood from TS Lee.

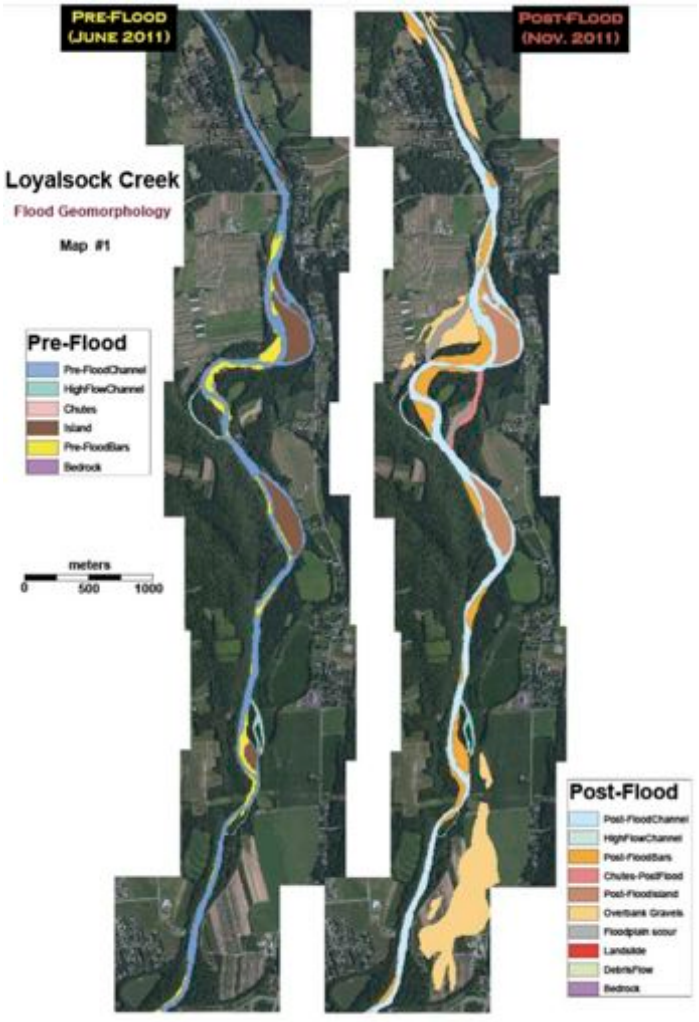
Assessing the Impact

Understanding the trajectory of these streams is critical for making wise management decisions and land use policy in North-Central Pennsylvania. These rivers are changing their morphology and behavior – returning to multi-threaded systems where flood flows occupy numerous channels across wide floodplains. This is the morphology consistent with the high gravel loads being delivered to channels from their watersheds today… and for decades to come. Knee-jerk reactions to the flooding such as "stream cleaning" will be futile because of the disequilibrium that is occurring throughout these formerly logged watersheds. There is a nearly endless supply of gravel coming down these streams to replace any gravel that is dredged. Additionally, dredging often creates a chain reaction of undesirable responses by the river that can worsen the problems in those areas and in neighboring stream reaches during future flooding ... not to say anything about the excessive destruction of aquatic life and habitat caused by these dredging activities. Highway and other infrastructure repairs should also take note of the trajectory of rivers in this region. Simply refilling lost reaches of eroded highways will be just a temporary fix until the next big flood. Likewise, farming and home building needs to be reevaluated in areas where chute formation and reconnections to multi-threaded floodplain systems are occurring. These kinds of changes will become exceedingly common during future floods.

Finally, we observed wholesale failure of stream restoration structures using Natural Channel Design (NCD) methods in streams across the region. Streams with large gravel loads are not conducive to control by NCD methods, resulting in enormous losses of expensive projects.

Looking Ahead

It is our hope that when finished, our flood geomorphic studies will document in detail the extensive changes that have occurred along four of the major streams tributary to the Susquehanna and West Branch Susquehanna River. Large maps documenting these changes will be available, as well as quantitative estimates of the geomorphic changes experienced by these streams. This research will demonstrate the role that historical land use has had upon the nature of river morphology and provide a guide to how rivers are likely to adjust to land use changes in the future. We hope that this information will be utilized by watershed managers, legislators, and governmental agencies to make informed decisions about wise land use in watersheds of North Central Pennsylvania.



Monitoring flooding across the watershed

Rapid response during storms yields valuable information

By Jessica Newlin, R. Craig Kochel, and Benjamin Hayes

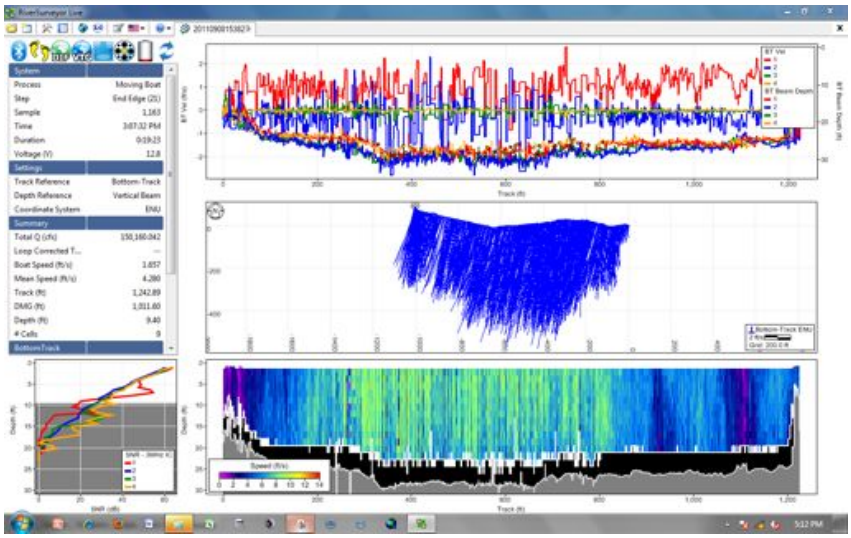
A major component of the Initiative is mapping and assessing the geomorphology and flow hydraulics of streams throughout the watershed, and as well as measuring the flow hydraulics and transport of sediment and nutrients in the river.

Since the infrequent, high-magnitude flow events perform the most geomorphic "work" (tractive force of the water times exerted over a length of channel) on streams, we often venture out during storms to collect data over a range of flow conditions. Using state-of-the-art hydroacoustic instruments we can now measure flow velocities in three dimensions across the entire water column, which greatly improves our discharge and shear stress estimates.

Suspended- and bedload-sediment samples are collected from bridges spanning the river using portable cranes; the data are used to calculate the volumes of clay, silt, sand, and gravel being transported by the river. For example, during Tropical Storm Lee, we estimate the West Branch was carrying at *least* 427,000 tons of suspended sediment per day — that's the equivalent of 28,500 dump trucks of sand and gravel!

This information is of great interest to U.S. Geological Survey, the U.S. Environmental Protection Agency and the Chesapeake Bay Commission. It improves our understanding of sediment erosion, transport and depositional processes in the river, how pools and riffle habitats are created, and the bathymetry and morphology of the channel. We hope to expand our monitoring of the river to learn more about the source areas of sediment and pollution in the watershed and how it affects the water quality and aquatic habitat in the river.

Collecting suspended sediment samples on Lycoming Creek near Trout Run (top) and the West Branch Susquehanna at Lewisburg (bottom) during TS Lee, September 8, 2011.



Sontek RiverSurveyor™ deployed off the Rt. 45 bridge in Lewisburg to measure discharge and variations in flow velocities across the river channel during the Sept 8, 2011 TS Lee flood. We are exploring the use of hydroacoustics for measuring flow hydraulics and sediment transport in sand and gravel bed rivers.

West Branch Susquehanna River at Watsontown, PA in Feb 2012. Photo by Ben Hayes

Watching the river flow

By Fred Swader

The Susquehanna River provides some sixty percent of the inflow to the Chesapeake Bay. The other tributaries are the Potomac and the James River, which provide twenty and ten percent, respectively. The outflow at the Conowingo Dam (the last gaging station in PA) is about 18 billion gallons per day (bgd), but has varied from 0.3 to 720 bgd.

LEWISBURG — The West Branch at Lewisburg drains an area of some 6,847 square miles, and extends 228 miles from its source to the confluence with the main stem (North Branch) at Northumberland.

In the final quarter of 2012, flow rates in the West Branch seldom exceeded the long-term median flow rates, so we can say that flow was "normal," except on November 2, when rainfall and runoff from Tropical Storm Sandy produced a short-term peak of nearly 26 million gallons per day (mgd).

October flows averaged 1.9 mgd; November flows averaged about 3.5 mgd; and December flows about 5.8 mgd.

DANVILLE — The river flow pattern is generally similar to that at Lewisburg, but at a higher flow level, since the watershed above Danville is some 11,220 square miles. The October estimated mean flow was about 3.6 mgd; November flow averaged about 6.5 mgd, with a sharp increase to 26 mgd on November 2, due to the effects of TS Sandy; and the mean flow for December was about 9.8 mgd. (Danville is the southernmost USGS gaging station before the confluence).

HARRISBURG — Harrisburg is the next downstream gaging station, with a drainage area of 24,100 square miles. Although not in the Central Susquehanna region, it provides some contrast to the values given above. Flows were near "normal" for October. Median flows for this period range from 5 mgd to 6.5 mgd.

A large spike occurred on November 1 and 2, due to TS Sandy. The flow rose from 10 mgd to 71 mgd, gradually returning to "normal" (13 mgd) by November 15, followed by a drop below "normal " to 7.2 mgd on December 7, and a large spike to nearly 90 mgd on Dec 22. December flows average about 18 mgd.

These data are extrapolated from flow rates in cubic feet per second, published by the US Geologic Survey and available online at:

`http://waterdata.USGS.gov.pa`

An aquatic laboratory

Snapshots

Faculty connecting students to the watershed through field-based learning experiences

Professor R. Craig Kochel teaching Advanced Geomorphology students how to map the channel profile and flood deposits in Muncy Creek watershed following Tropical Storm Lee (note flood debris in background).

Professor Jessica Newlin helping students with velocity and river mechanics laboratory to evaluate sediment erosion and deposition at bridge and cross vein structures in White Deer Creek, Union County.

Professor Michael Malusis collecting subsurface samples at the Long-Term Environmental Research facility at Montandon Marsh, a palustrine wetland and former paleochannel of the Susquehanna River during the Pleistocene.

Professor Matthew McTammany (left) helping summer research interns Matt Wilson (middle) and Ashley Bruno conduct a detailed macroinvertebrate study on the river.

Professor Kevin Gilmore helping a Civil and Environmental Engineering student collecting samples near Lewisburg to determine levels of bromide and other constituents in the river.

Wyalusing Rocks field trip stop for Bucknell-on-the-Susquehanna (UNIV 291) students, on the Initiative's three-week field intensive course which takes students from the headwaters of the Susquehanna to the Chesapeake and to the Olympic Penninsula and the Puget Sound.

Presenting our findings

A sampling of presentations of Initiative-associated research given at regional and national conferences in the past year:

HAYES, Benjamin R. and NEWLIN, Jessica T., 2012. *Use of Hydro-Acoustics in Undergraduate Teaching and Research: Measuring Flow Hydraulics, River Bedforms, and Sediment Discharge in the Susquehanna Watershed, North-Central Pennsylvania*, Joint U.S. Geological Survey and Consortium of Universities for the Advancement of Hydrologic Sciences Workshop on Sediment-Hydroacoustics, National ConservationTraining Center, Shepherdstown, WV, March 5-7.

MCTAMMANY, Matthew; FREEMAN, Joanna W.*, and Molly L.D. CLARK*, 2012. *Influences of Biogeochemical Processes in reservoirs and groundwater on Catchment-Scale Water Chemistry in a Forested Stream in Central Pennsylvania*. Abstract ID 6821, Annual Meeting of the Society of Freshwater Sciences, Louisville, KY, May 20-24.

WILSON, Matthew J.*; Matthew E. MCTAMMANY; Benjamin R. HAYES; Sean P. REESE; and Michael BILGER, 2012. *Spatial and Temporal Patterns of Benthic Invertebrate Communities in the Susquehanna River Revealed Using Data from Twenty Years of Surveys by Multiple Agencies,* Abstract ID 7010, Annual Meeting of the Society of Freshwater Sciences, Louisville, KY, May 20-24.

HAYES, Benjamin R.; NEWLIN, Jessica T.; MCTAMMANY, Matthew; LANGDON, Kevin; and REESE, Sean P., 2012. *Monitoring of Water Quality and Flow Hydraulics on the Susquehanna River in Central Pennsylvania,* American Society of Civil Engineers Hydraulic Measurement and Experimental Methods Conference, Snowbird, UT, August 12-15.

HUFFNER, Michael*, REESE, Sean P. and MCTAMMANY, Matthew E, 2012. *Mussel Populations and Distributions on Buffalo Creek, an American Eel Stocked Tributary to the West Branch Susquehanna River*, 7th Annual Susquehanna River Symposium, Bucknell University, Lewisburg, PA, October 12-13.

UEHLING, Paige*; and MCTAMMANY, Matthew E, 2012. *Influence of Filter Feeders on Seston Availability and Quality and Resulting Longitudinal Change in Filter-Feeder Abundance and Composition*, 7th Annual Susquehanna River Symposium, Bucknell University, Lewisburg, PA, October 12-13.

MCTAMMANY, Matthew, BRUNO, Ashley*, and WILSON, Matthew*, 2012. *Spatial Variability of Benthic Invertebrate Comunities in the West Branch Susquehanna River*, 7th Annual Susquehanna River Symposium, Bucknell University, Lewisburg, PA, October 12-13.

YEE, Kayla; NEWLIN, Jessica T.; and HAYES, Benjamin R., 2012. *Bedform and Sediment Characterization of the West Branch of the Susquehanna River*, 7th Annual Susquehanna River Symposium, Bucknell University, Lewisburg, PA, October 12-13.

HAYES, Benjamin R., LANGDON, Kevin; REESE, Sean P.; and MCTAMMANY, Matthew E., 2012. *Development of Relational Database and Web Portal Software to Manage and Display Real-Time Data from a Remotely-Deployed Network of Water Quality Sondes*, 7th Annual Susquehanna River Symposium, Bucknell University, Lewisburg, PA, October 12-13.

MCGUIRE, Molly M. and HERMAN, Ellen K., 2012. *A New Technique for Identifying Colloids Mineralogy in Karst Waters: Apply ATR-FTIR Spectroscopy and AFM to Karst Colloids,* Paper No. 177-10, Annual Meeting Geological Society of America, Charlotte, NC, November 4-7.

HAYES, Benjamin R.; KOCHEL, R. Craig; and NEWLIN, Jessica T., 2012. *Post-Flood Alternatives for River Corridor Management in Central Pennsylvania: Helping Resolve River and Land Use Conflicts in an Economically and Ecologically Sustainable Manner*, White Paper prepared for Pennsylvania State Legislators and presented at 7th Annual Susquehanna River Symposium, Bucknell University, Lewisburg, PA, October 12-13.

KOCHEL, R. Craig and HAYES, Benjamin R., 2012. *Catastrophic Flooding in North-Central Pennsylvania (Tropical Storm Lee - September 2011): Intersection of Fluvial Equilibrian and the Legacy of Logging,* Paper No. 115-3 in the *Special Session: The Fluvial System - The Legacy of Stanley A. Schumm (Invited Oral Session)*, Annual Meeting Geological Society of America, Charlotte, NC, November 4-7.

KISSOCK, Kyle* and KIRBY, Carl S., and DONAGHY, Erin*, 2012. *Long Term Effects f a Passive Remediation Treatment System on an Adic-Impaired Headwater Stream in Union County, Pennsylvania,* Poster No. 156-25, Annual Meeting Geological Society of America, Charlotte, NC, November 4-7.

KOCHEL, R. Craig; MUHLBAUER, Jason*; HANCOCK, Zachary*; ROCKWELL, Darin*; SIRIANNI, Matthew*, and HAYES, Benjamin, 2012. *The "Gravel Flood": Coarse-Grained Sediment Transport in Gravel Bed Streams During Tropical Storm Lee in North-Central Pennsylvania (September, 2011),* Paper No. 168-7 in the *Special Session: The Fluvial System - The Legacy of Stanley A. Schumm (Poster Session)*, Annual Meeting Geological Society of America, Charlotte, NC, November 4-7.

MUHLBAUER, Jason* and KOCHEL, R. Craig, 2012. *Catastrophic Flooding in North-Central Pennsylvania: Geomorphic Findings from the September 2011 Event and Their Significance to Sedimentology,* Paper No. 168-8 in the *Special Session: The Fluvial System - The Legacy of Stanley A. Schumm (Poster Session)*, Annual Meeting Geological Society of America, Charlotte, NC, November 4-7.

HANCOCK, Zachary*; KOCHEL, R. Craig; MUHLBAUER, Jason*; ROCKWELL, Darin*; SIRIANNI, Matthew*; and HAYES, Benjamin, 2012. *Geomorphic Impact of Catastrophic Flooding from Tropical Storm Lee (September, 2011) in Gravel-Bed Streams of the Appalachian Plateau, North-Central Pennsylvania*, Paper No. 168-9 in the *Special Session: The Fluvial System - The Legacy of Stanley A. Schumm (Poster Session)*, Annual Meeting Geological Society of America, Charlotte, NC, November 4-7.

ROCKWELL, Darin; KOCHEL, R. Craig; HANCOCK, Zachary*; SIRIANNI, Matthew*; and HAYES, Benjamin, 2012. *Basin-Scale Influence on the Geomorphic Impacts of the Tropical Storm Lee Flood (September, 2011) in North-Central Pennsylvania*, Paper No. 168-10 in the *Special Session: The Fluvial System - The Legacy of Stanley A. Schumm (Poster Session)*, Annual Meeting Geological Society of America, Charlotte, NC, November 4-7.

NEWLIN, Jessica T; CHARLAND, Brian*; SCHULTZ, Brian*; and HAYES, Benjamin R., 2012. *History of Sediment Aggradation at Bridges in Pennsylvania and its Effects on Flood Damage in 2011*, Annual meeting of the American Water Resources Association, Jacksonville, FL, Nov. 12-15.

** Bucknell student*

Bucknell Susquehanna River Initiative

The Susquehanna River Initiative creates new teaching, research, and outreach opportunities for faculty and students at Bucknell University. It focuses primarily in the hydrologic, ecologic, and engineering sciences, but also involves others in the humanities and social sciences, especially related to historical changes in land use, cultures, and communities in the watershed. Sustainability, global connections, and long-term changes are important issues being addressed by the faculty and students involved in Initiative studies.

In addition to the river monitoring, aquatic community assessments, and habitat studies, the Initiative maintains instrumented field stations at the Montandon wetlands and Roaring Creek forested watershed and leads educational paddling sojourns and natural history outings.

Public outreach activities include stream and wetland restoration projects, teaching workshops, annual river symposia, and public seminars.

Environmental data and discoveries are shared with our collaborative research partners, including the Susquehanna River Heartland Coalition for Environmental Studies, U.S. Geological Survey, Chesapeake Bay Commission, Smithsonian Institution, Susquehanna River Basin Commission, Pennsylvania Department of Environmental Protection, U.S. Environmental Protection Agency, and the Nature Conservancy.

New Interdisciplinary Courses

- Watershed System Science
- Stream Restoration
- Bucknell-On-The-Susquehanna (BotS)

Scholarly Research

- River ecosystems and aquatic habitat
- Fluvial processes and channel change
- Sediment transport and erosion
- Watershed hydrology and flooding
- Groundwater-stream connections
- Wetlands hydrology and ecology
- Stream restoration and river engineering

Community Outreach and Service

- Contributing to the River Basin Commission's *State-Of-The-Susquehanna* assessment
- Stream and wetlands restoration projects
- Annual Susquehanna River Symposium
- Ecologic and Geomorphic Factors for Stream Restoration (short course)
- Instrumented teaching and research facilities

Susquehanna River Initiative
Bucknell University Environmental Center
One Dent Drive
Lewisburg, PA 17844